



**A SEMI-ANNUAL AQUATIC MONITORING REPORT FOR A
SURFACE MINE PERMIT (DMLR # 1101760) LOCATED NEAR
ROARING FORK IN WISE COUNTY, VIRGINIA**

**Prepared for:
Red River Coal Company, Inc**

**Authored by:
Chris Isaac**

ATS PROJECT NO. 1199.01

March 2012

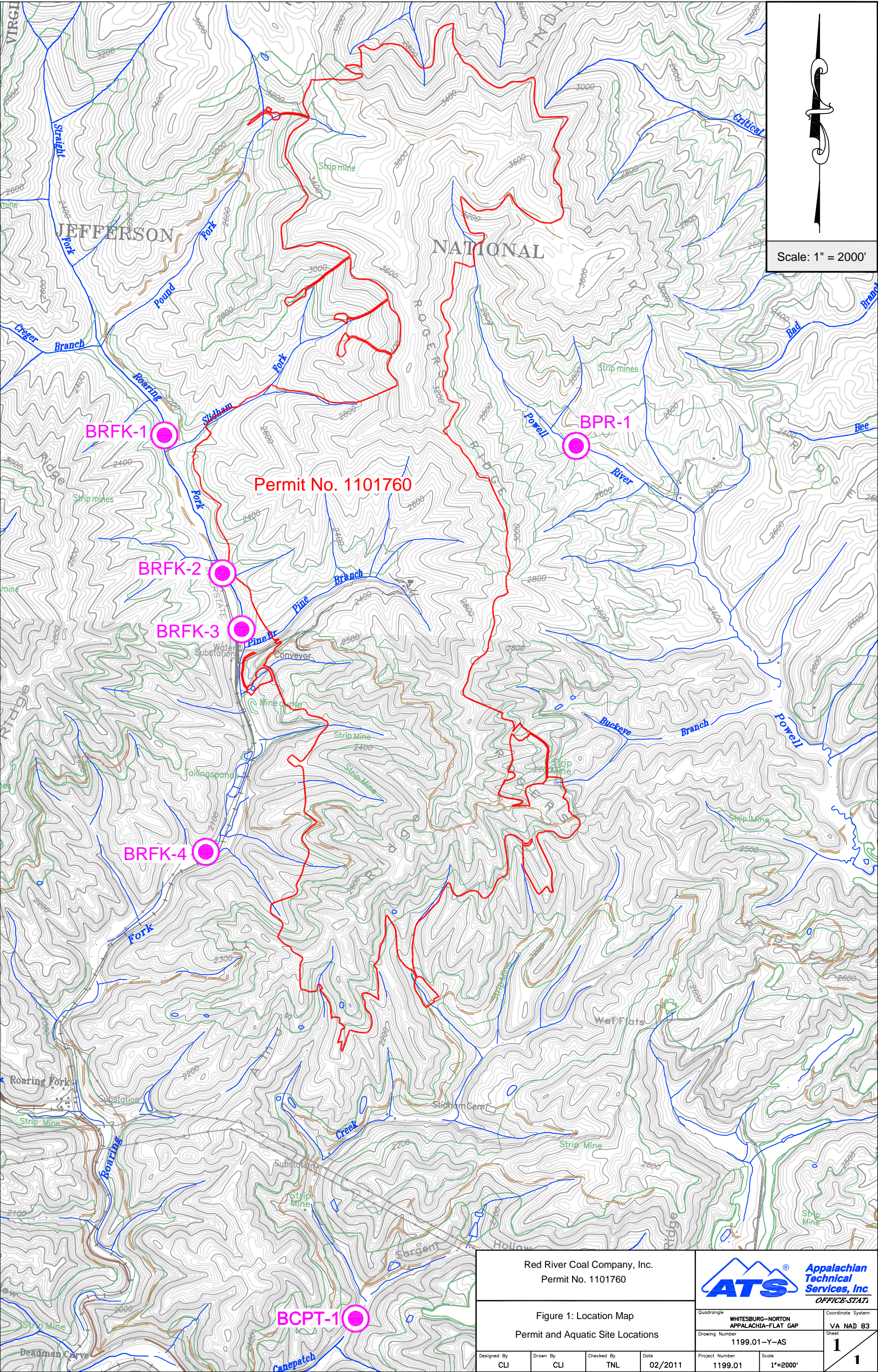
I. INTRODUCTION


Appalachian Technical Services, Inc. was contracted by Red River Coal Company, Inc to conduct ongoing semi-annual (spring and fall) aquatic monitoring at six sites within the Guest River drainage in Wise County, Virginia. This report represents the spring 2012 aquatic biological assessments of six sample sites. The permit boundary and sample site locations are shown on the attached topographical map in Figure 1.

II. METHODS

General locations of all sample sites were selected by a Virginia DMLR biologist. However, the exact site locations may have been relocated by ATS senior biologists due to site conditions (*i.e.* low flow, lack of riffle habitat, etc.) and accessibility. Aquatic sampling site BRFK-1 was located on Roaring Fork approximately 50 m upstream of the confluence with Stidham Fork (37.0128; 82.72918). Aquatic sampling site BRFK-2 was located on Roaring Fork approximately 400 m upstream of sample site BFRK-3 (37.00595; 82.72583). Aquatic sampling site BRFK-3 was located on Roaring Fork approximately 50 m upstream of the confluence to Pine Branch (37.00037; 82.72239). Aquatic sampling site BRFK-4 was located southeast of the permit on Roaring Fork approximately 450 m downstream of a series of sediment ponds (39.98554; 82.72417). Aquatic sampling site BCPT-1 was southeast of the permit and located on Canepatch Creek approximately 100 m downstream of the confluence to Sargent Hollow (36.97016; 82.70624). Aquatic sampling site BPR-1 was located to the east of the permit boundary in the upper headwaters of the Powell River approximately 50 m upstream of Red River Coal Company's haulroad (37.01271; 82.69608).

Data collections for the aquatic biological assessment consisting of habitat data, macroinvertebrates and physiochemical water quality data were collected on 14 March 2012 by ATS Biological Technicians Brian Bledsoe, Joseph Day and James Breeding.



| | | | | | |
|---|----------|------------|---------|--|--|
| Red River Coal Company, Inc. Permit No. 1101760 | | | |  Appalachian Technical Services, Inc. <i>OFFICE-STATION</i> | |
| Figure 1: Location Map Permit and Aquatic Site Locations | | | | Quadrangle | WHITESBURG-NORTON APPALACHIA-FLAT GAP |
| | | | | Drawing Number | 1199.01-Y-AS |
| Designed By | Drawn By | Checked By | Date | Project Number | Scale |
| CLI | CLI | TNL | 02/2011 | 1199.01 | 1"=2000' |
| | | | | Coordinate System | VA NAD 83 |
| | | | | Sheet | 1 |
| | | | | | 1 |

A. Habitat Assessments

Rapid Bioassessment Protocol (RBP) high gradient data sheets were used to assess the habitat for each stream. The RBP sheets score each site's habitat based on 10 criteria with 1 - 20 possible points each (for a max total of 200). Based on the *2008 Methods for Assessing Biological Integrity of Surface Waters in Kentucky, Revision 3* (KDOW 2008), stream habitat in the central Appalachians Ecoregion is considered not supporting its designated use if the total score is less than or equal to 116 total points. Habitat must score 117 – 159 to achieve a partially supporting criterion. To qualify as fully supporting habitat, it must score at least 160 total points. Copies of the stream habitat data sheets are attached in Appendix A.

B. Aquatic Macroinvertebrates

Macroinvertebrates were collected using the single habitat approach as described in sections 7.1.1 and 7.3.1 of the *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition* (Barbour *et al.* 1999).

Macroinvertebrates were collected by agitating a riffle area of 0.25 meters in front of a standard size (500 Φ m mesh) kicknet. This process was repeated eight times to achieve 2 square meters of sample area. Upon collection, samples from each site were placed in individual containers of 95% ethyl alcohol, labeled, and returned to the lab.

Subsampling procedures followed methods within Appalachian Technical Services, Inc.'s Virginia Department of Environmental Quality approved *Quality Assurance Project Plan for Biological Monitoring, 2010* and resulted in the identification of approximately 110 ($\pm 10\%$) individuals. All macroinvertebrates were identified by a North American Benthological Society certified taxonomist to family level with the exception of Chironomidae and Oligochaeta.

Macroinvertebrate metrics were calculated based on the methods included in *A Stream Condition Index for Virginia Non-Coastal Streams* (Tetra Tech, Inc. 2003). ATS

biologists used the Ecological Data Application System (EDAS) to statistically rarify the samples to 110 organisms and calculate VSCI scores. The VSCI is used to compare streams to reference conditions to evaluate a streams current health. A stream must score a 61 or above to qualify as acceptable water quality. In order to calculate the VSCI the following metrics were calculated from the family level aquatic macroinvertebrate data: Taxa richness; Ephemeroptera, Plecoptera, Trichoptera (EPT) Index; Percent Ephemeroptera; Percent Plecoptera + Trichoptera (less Hydropsychidae); Percent Scrapers; Percent Chironomidae; Percent of top two dominant families; and Family Biotic Index (FBI). Tables with the macroinvertebrate data are attached in Appendix B.

C. Physiochemical Water Data

Prior to any field data collections, all handheld meters were calibrated. Four water quality parameters (specific conductance, dissolved oxygen, pH, and temperature) were analyzed using a handheld meter (YSI Pro Plus). Upon return to the lab all meters received a post-calibration check to ensure validity of all measurements recorded.

III. RESULTS

A. Habitat Assessments

The stream habitat at BRFK-1 scored 133 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 18 feet wide and characterized mostly by a series of riffles and runs (Figures 2 and 3). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The water was clear and there was slight siltation within the streambed. The stream banks were moderately stable but the left bank had a narrow riparian zone. The substrate was mostly gravel and cobble.

The stream habitat at BRFK-2 scored 126 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 18 feet wide

and characterized mostly by a series of riffles and runs (Figures 4 and 5). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there was evidence of slight siltation within the streambed. The stream banks were moderately stable but the right bank had a narrow riparian zone. The substrate was mostly gravel and cobble.

The stream habitat at BRFK-3 scored 130 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 20 feet wide and characterized mostly by a series of riffles and runs (Figures 6 and 7). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there was evidence of slight to moderate siltation within the streambed. The left stream bank vegetative protection and riparian width were suboptimal to optimal while the right was marginal to suboptimal. The substrate was mostly gravel and cobble.

The stream habitat at BRFK-4 scored 119 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 20 feet wide and characterized mostly by a series of riffles and runs (Figures 8 and 9). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there was evidence of moderate sedimentation within the streambed. Both stream banks had suboptimal vegetation and good riparian zones. The substrate was mostly gravel and cobble.

The stream habitat at BCPT-1 scored 123 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 10 feet wide and was series of riffles, runs and pools (Figures 10 and 11). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there

was evidence of moderate sedimentation within the streambed. The stream banks were moderately unstable and the right bank had a narrow riparian area. The substrate was mostly gravel and cobble.

The stream habitat at BPR-1 scored 129 of 200 (Appendix A), indicating the habitat is partially supporting aquatic life. The stream was approximately 5 feet wide and characterized mostly by a series of runs and riffles (Figures 12 and 13). Flow occupied >75% of the stream channel. Embeddedness was suboptimal with approximately 25 to 50% of the substrate particles surrounded by fine sediment. The coloration of the water was clear and there was evidence of slight siltation within the streambed. The stream banks were unstable but with good riparian areas. The substrate was mostly gravel.

B. Macroinvertebrates

Sample site BPR-1 had the highest Taxa Richness (Tables 1 and 2). Sample site BRFK-3 had the lowest Taxa Richness (Tables 1 and 2). Sample site BPR-1 had the lowest FBI score (3.35), indicating excellent water quality with organic pollution unlikely (Table 2). FBI scores for the six sample sites indicated fairly poor (5.77) to excellent (3.35) water quality (Table 2). VSCI scores for the six aquatic sample sites ranged from a low of 28.71 (BRFK-3) to a high of 66.66 (BPR-1) (Table 2).

C. Physiochemical Water Data

All handheld meters passed post-calibration tests. Specific conductances for the six sites ranged from 807 μ S (BCPT-1) to 1182 μ S (BRFK-2) (Table 3). The pH values ranged from 7.97 (BRFK-1) to 8.37 (BRFK-4) (Table 3).

IV. CONCLUSION

Based on RBP habitat data, all six sample sites appear to be somewhat impaired. Habitat assessments revealed that the habitat was marginal to suboptimal at all six sample sites. Only sample site BPR1 had a VSCI score above the unimpaired threshold of 61. The other five sample sites had low percent Ephemeroptera, low

percent scrapers, and high percent two dominants. These low parameter indices may have contributed to the sample sites receiving poor VSCI scores. All water parameters recorded with a handheld meter were within normal limits with an exception of elevated specific conductances at all six sample sites.



Figure 2: BRFK-1 upstream view



Figure 3: BRFK-1 downstream view



Figure 4: BRFK-2 upstream view



Figure 5: BRFK-2 downstream view



Figure 6: BRFK-3 upstream view



Figure 7: BRFK-3 downstream view



Figure 8: BRFK-4 upstream view



Figure 9: BRFK-4 downstream view



Figure 10: BCPT-1 upstream view



Figure 11: BCPT-1 downstream view



Figure 12: BPR-1 upstream view



Figure 13: BPR-1 downstream view

Literature Cited

- Barbour, M. T., J. Gerritsen, B. D. Snyder, and J. B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.
- Kentucky Division of Water (KDOW), 2008. Methods for assessing biological integrity of surface waters in Kentucky, Revision 3. Kentucky Department of Environmental Protection, Division of Water, Frankfort, Kentucky.
- Tetra Tech, Inc. 2003. A Stream Condition Index for Virginia Non-Coastal Streams. Tetra Tech, Inc. Owings Mills, Maryland. Prepared for Virginia Department of Environmental Quality, Richmond, Virginia.

APPENDIX A:

RBP DATA

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BRFL Ecoregion: _____ Land Use: Mining
 Field Team: DEB, BWR, SDO Survey Reason: Big. Monitoring Start Time: 14:16
 Stream Name: Bearing Fork Location: 50m below gas line crossing adjacent to rail road tracks Finish Time: 14:45

Date: 3/14/12 Latitude: 37.01218 Longitude: 82.72918

Stream Physicochemical

Instrument ID number: VSI-PRO pH: 7.97
 Temperature: 12.6 °C Conductivity: 1147 µS/cm
 Dissolved Oxygen: 11.90 mg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor Banks None Vegetation Area Sampled (sq. m): 2m²
 Habitats sampled (circle one) Riffle Snags # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 0.2 - 1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☒ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type:
☒ Trees ☒ Shrubs
☐ Grasses ☒ Herbaceous
 Number of strata 3

Dom. Tree/Shrub Taxa

Redoak
Birch
maple

Canopy Cover:

☐ Fully Shaded (75-100%)
☒ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full Partial)

Substrate 0 Est. 0 P.C.

Riffle 30 %

Run 70 %

Pool 0 %

High Gradient Habitat Data Sheet

1. Epifaunal

Substrate/Available Cover

| Optimal | Suboptimal | Marginal | Poor |
|---|--|--|--|
| Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not translucent). | 40-70% m/s of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |

SCORE 20 19 18 17 16

2. Embeddedness

| Optimal | Suboptimal | Marginal | Poor |
|--|---|---|--|
| Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |

SCORE 20 19 18 17 16

3. Velocity/Depth Regime

| Optimal | Suboptimal | Marginal | Poor |
|--|--|---|---|
| Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5 | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE | | | | |

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BRFK2 Ecoregion: _____ Land Use: mining
 Field Team: JEB, BWB, JDD Survey Reason: Bio-Monitoring Start Time: 12:40 13:20
 Stream Name: Roaring Fork Location: Adjacent to haul rd. Finish Time: 13:50

Date: 3/14/12 Latitude: 37.00595°N Longitude: 82.72583°W

Stream Physicochemical

Instrument ID number: 455-PRO pH: 8.22
 Temperature: 13.0 °C Conductivity: 1182 µS/cm
 Dissolved Oxygen: 11.98 mg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Snags Poor Banks None Vegetation
 Habitats sampled (circle one) _____ Area Sampled (sq. m.): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 18 ft
 Range of Depth 0.2 - 1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☒ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Rpkr
☒ Trees ☒ Shrubs
☒ Grasses ☐ Herbaceous
 Number of strata 3

Don't Tree/Shrub Taxa

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☒ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full Partial)

Substrate ☐ Est. OP.C.

Riffle 45 %

Run 55 %

Pool 0 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Avaliable Cover

| Optimal | Suboptimal | Marginal | Poor |
|--|--|--|--|
| Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transients). | 40-70% m/s of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

2. Embeddedness

| Optimal | Suboptimal | Marginal | Poor |
|--|---|---|--|
| Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

3. Velocity/Depth Regime

| Optimal | Suboptimal | Marginal | Poor |
|--|--|---|---|
| Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5 | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40 - 80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

SCORE

126

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199-01-BRFK3 Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BWB, JDD Survey Reason: Bio. Monitoring Start Time: 12:40
 Stream Name: Boaring Fork Location: Adjacent to haul rd. Finish Time: 13:10
100m above haul rd crossing

Date: 3/14/12 Latitude: 37.00037°N Longitude: 82.72239°W

Stream Physicochemical

Instrument ID number: YSI-PRO pH: 8.31
 Temperature: 12.6 °C Conductivity: 1163 µS/cm
 Dissolved Oxygen: 1193 µg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Snags Poor Banks None Vegetation
 Habitats sampled (circle one) Riffle Area Sampled (sq. m): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 20 ft
 Range of Depth 0.2 - 1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☒ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type:
☒ Trees ☒ Shrubs
☐ Grasses ☒ Herbaceous
 Number of strata 3

Dom. Tree/Shrub Taxa

Rododendron
Sycamore
Poplar

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☒ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ (Full/Partial)

Substrate ☐ Est. OP.C.

Riffle 40 %

Run 60 %

Pool 0 %

High Gradient Habitat Data Sheet

1. Epifaunal
 Substrate/Available
 Cover

| Optimal | Suboptimal | Marginal | Poor |
|--|--|--|--|
| Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transients). | 40-70% mls of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |

2. Embeddedness

| Optimal | Suboptimal | Marginal | Poor |
|--|---|---|--|
| Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |

3. Velocity/Depth
 Regime

| Optimal | Suboptimal | Marginal | Poor |
|--|--|---|---|
| Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5 | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40 - 80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

SCORE

130

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199.01-BBPKY Ecoregion: _____ Land Use: Mining
 Field Team: Feb. BWR, JDD Survey Reason: Bio. monitoring Start Time: 11:40
 Stream Name: Bearing Fork Location: Adjacent to haul rd Finish Time: 12:10

Date: 3/14/12 Latitude: 36.98554 Longitude: 82.72417
 Stream Physicochemical

Instrument ID number: YSI-PRO pH: 6.37
 Temperature: 12.8 °C Conductivity: 1180 µS/cm
 Dissolved Oxygen: 12.14 mg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Poor Banks None Vegetation Area Sampled (sq. m): 2m²
 Habitats sampled (circle one) # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 20 ft
 Range of Depth 0.2-2.5 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☒ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Sycamore
☒ Trees ☒ Shrubs
☒ Grasses ☐ Herbaceous
 Number of strata 3

Dom. Tree/Shrub Taxa

Sycamore
Poplar

Canopy Cover:

☐ Fully Shaded (75-100%)
☒ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ Full ☐ Partial

Substrate Ø Est. OP.C.

Riffle 55 %

Run 40 %

Pool 5 %

High Gradient Habitat Data Sheet

1. Epifaunal

Substrate/Available Cover

Optimal

Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at slope to allow full colonization potential (i.e. logs/snags that are not new fall and not transient).

Suboptimal

40-70% mls of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale).

Marginal

20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.

Poor

Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

2. Embeddedness

Optimal

Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.

Suboptimal

Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.

Marginal

Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.

Poor

Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

3. Velocity/Depth Regime

Optimal

Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5

Suboptimal

Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).

Marginal

Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).

Poor

Dominated by 1 velocity/depth regime (usually slow-deep).

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |

SCORE

119

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199-01-BCPT1 Ecoregion: _____ Land Use: Mining
 Field Team: JEB, BWB, JDO Survey Reason: Bio. Monitoring Start Time: 8:30
 Stream Name: Cane Patch Branch Creek Location: Adjacent to haul Rd. 360m below Confluence Finish Time: 9:00

Date: 3/4/12 Latitude: 39.97016 Longitude: 82.70624
 Stream Physicochemical

Instrument ID number: YS-PRO pH: 8.17
 Temperature: 11.9 °C Conductivity: 807 µS/cm
 Dissolved Oxygen: 11.89 mg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Snags Poor Banks None Vegetation
 Habitat sampled (circle one) Riffle Area Sampled (sq. m): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 12 ft
 Range of Depth 0.20-2 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☐ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Sycamore
☒ Trees ☒ Shrubs Hemlock
☐ Grasses ☐ Herbaceous Rododendron
 Number of strata 3

Canopy Cover:

☐ Fully Shaded (75-100%)
☐ Partially Shaded (50-75%)
☒ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ Full ☐ Partial

Substrate ØEst. OP.C.

Riffle 40 %

Run 45 %

Pool 15 %

High Gradient Habitat Data Sheet

1. Epifaunal

Substrate/Available Cover

| Optimal | Suboptimal | Marginal | Poor |
|---|--|--|--|
| Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not new fall and not transient). | 40-70% m/s of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |

SCORE 20 19 18 17 16

2. Embeddedness

| Optimal | Suboptimal | Marginal | Poor |
|--|---|---|--|
| Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |

SCORE 20 19 18 17 16

3. Velocity/Depth Regime

| Optimal | Suboptimal | Marginal | Poor |
|--|--|---|---|
| Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5 | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffled divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE | | | | |

SCORE

123

Benthic Macroinvertebrate Field Data Sheet (front)

Station ID: 1199-01-BPR1 Ecoregion: _____ Land Use: _____
 Field Team: JEB, BWR, JDD Survey Reason: Bio. Monitoring Start Time: 15:15
 Stream Name: Powell River Location: 50m above old haul rd crossing. Finish Time: 15:45

Date: 3/14/12 Latitude: 37.01221°N Longitude: 82.69608°W
 Stream Physicochemical

Instrument ID number: YSI-PRO pH: 8.12
 Temperature: 14.1 °C Conductivity: 165 µS/cm
 Dissolved Oxygen: 4.40 mg/l Did instrument pass all post-calibration checks? Y/N
 If NO - which parameter(s) failed and action _____

Benthic Macroinvertebrate Collection

Method used (circle one) Single Habitat (Riffle) Multi Habitat (Logs, plants, etc)
 Riffle Quality (circle one) Good Marginal Snags Poor Banks None Vegetation
 Habitats sampled (circle one) Riffle Area Sampled (sq. m.): 2m²
 # Jabs _____

Weather Observations

Current Weather (circle one) Cloudy Clear Rain/Snow Foggy
 Recent precipitation (circle one) Clear Showers Rain Storms Other _____
 Stream flow (circle one) Low Normal Above Normal Flood

INSTREAM WATERSHED FEATURES:

Stream Width 10 ft
 Range of Depth 0.2-1.0 ft
 Average Velocity _____ ft/s
 Discharge _____ cfs
 Est. Reach Length _____

LOCAL WATERSHED FEATURES:

Predominant Surrounding Land Use:

☒ Surface Mining ☐ Construction ☒ Forest
☒ Deep Mining ☐ Commercial ☐ Pasture/Grazing
☐ Oil Wells ☐ Industrial ☐ Silviculture
☐ Land Disposal ☐ Row Crops ☐ Urban Runoff/Storm Sewers

Hydraulic Structures:

☐ Dams ☐ Bridge Abutments
☐ Island ☐ Waterfalls
☐ Other _____

Stream Flow:

☐ Dry ☐ Pooled ☐ Low ☒ Normal
☐ High ☐ Very Rapid or Torrential

Stream Type:

☒ Perennial ☐ Intermittent
☐ Ephemeral ☐ Seep

Riparian Vegetation:

Dominant Type: Poplar
☒ Trees ☐ Shrubs
☒ Grasses ☒ Herbaceous
 Number of strata 3

Dom. Tree/Shrub Taxa

Maple

Canopy Cover:

☐ Fully Shaded (75-100%)
☒ Partially Shaded (50-75%)
☐ Partially Exposed (25-50%)
☐ Fully Exposed (0-25%)

Channel Alterations:

☐ Dredging
☐ Channelization
☐ Full ☐ Partial

Substrate ☐ Est. OP.C.

Riffle 50 %

Run 45 %

Pool 5 %

High Gradient Habitat Data Sheet

1. Epifaunal Substrate/Available Cover

| Optimal | Suboptimal | Marginal | Poor |
|--|--|--|--|
| Greater than 70% of substrate favorable for epifauna colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e. logs/snags that are not now fall and not transitory). | 40-70% mls of stable habitat; well suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of new fall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

2. Embeddedness

| Optimal | Suboptimal | Marginal | Poor |
|--|---|---|--|
| Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space. | Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment. | Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment. | Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment. |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

3. Velocity/Depth Regime

| Optimal | Suboptimal | Marginal | Poor |
|--|--|---|---|
| Cover All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). Slow is <0.3 m/s, deep is >0.5 | Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes). | Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low). | Dominated by 1 velocity/depth regime (usually slow-deep). |

SCORE 20 19 18 17 16

15 14 13 12 11

10 9 8 7 6

5 4 3 2 1

| | | | | |
|--|---|---|--|--|
| 4. Sediment Deposition | Optimal Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition. | Suboptimal Some new increase in bar formation, mostly from gravel, sand or fine sediment. 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools. | Marginal Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of | Poor Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent. |
| SCORE | 20 19 18 17 16 m/s. | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 5. Channel Flow Status | Optimal Water reaches base of both lower banks, and minimal amount of channel substrate is exposed. | Suboptimal Water fills >75% of the available channel; or 25% of channel substrate is exposed. | Marginal Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed. | Poor Very little water in channel and mostly present as standing pools. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 6. Channel Alteration | Optimal Channelization or dredging absent or minimal; stream with normal pattern. | Suboptimal Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr.) may be present, but recent channelization is not present. | Marginal Channelization may be extensive; embankments or shoring structures present on both banks; and 40-80% of stream reach channelized and disrupted. | Poor Banks shored with gabion or cement over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 7. Frequency of Riffles (or bends) | Optimal Occurrence of riffles relatively frequent ratio of distance btw. riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitats if key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important. | Suboptimal Occurrence of riffles infrequent; distance btw. riffles divided by the width of the stream is btw. 7 to 15. | Marginal Occasional riffle or bend; bottom contours provide some habitat; distance btw. riffles divided by the width of the stream is btw. 15 to 25. | Poor Generally all flat water or shallow riffles; poor habitat; distance btw. riffles divided by the width of the stream is a ratio of >25%. |
| SCORE | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 |
| 8. Bank Stability (score each bank) | Optimal Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. < 5% of bank affected. | Suboptimal Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion. | Marginal Moderately unstable, 30-60% of bank in reach has areas of erosion; high erosion potential during floods. | Poor Unstable; many eroded areas "raw" areas |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 9. Vegetative Protection (score each bank) | Optimal More than 90% of the stream bank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | Suboptimal 70-90% of stream bank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | Marginal 50-70% of the stream bank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Poor Less than 50% of the stream bank surfaces covered by vegetation; disruption of stream bank vegetation is very high; vegetation has been removed to 5 cm or less in average stubble height. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| 10. Riparian Vegetative Zone Width (score each bank) | Optimal Width of riparian zone >18 m; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone. | Suboptimal Width of riparian zone 12-18 m; human activities have impacted zone only minimally. | Marginal Width of riparian zone 6-12 m; human activities have impacted zone a great deal. | Poor Width of riparian zone <6 m; little or no riparian vegetation due to human activities. |
| SCORE RB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE LB | 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| SCORE | | | | 129 |

APPENDIX B:

TABLES

Table 1. Quantitative listings of macroinvertebrates collected 14 March 2012 from six aquatic sample sites for a surface mine permit number 1101760 in Wise County, Virginia.

| Order | Family | Spring 2012 | | | | | |
|---------------|------------------|-------------|--------|--------|--------|--------|-------|
| | | BRFK-1 | BRFK-2 | BRFK-3 | BRFK-4 | BCPT-1 | BPR-1 |
| Ephemeroptera | Ameletidae | | | | | 1 | 1 |
| | Baetidae | | | | 9 | 12 | 17 |
| | Heptageniidae | | | | 1 | 1 | |
| Plecoptera | Leuctridae | | | | | | 7 |
| | Nemouridae | 13 | 1 | 7 | 10 | 64 | 33 |
| | Perlodidae | | | | | | 4 |
| Trichoptera | Hydropsychidae | 70 | 52 | 64 | 35 | 21 | 10 |
| | Philopotamidae | 1 | 2 | 1 | | | |
| | Rhyacophilidae | 1 | | | | | |
| | Uenoidae | | | | | 1 | |
| Coleoptera | Elmidae | | | | | | 22 |
| Diptera | Ceratropogonidae | | | 1 | | | |
| | Chironomidae | 12 | 35 | 39 | 39 | 8 | 7 |
| | Empididae | 2 | 7 | 4 | 6 | 2 | 2 |
| | Tipulidae | 4 | 4 | | 1 | | 1 |
| Megaloptera | Corydalidae | | | | | 1 | |
| | Sialidae | 1 | | | | | |
| Decapoda | Cambaridae | | 1 | | | | |
| Annelida | Oligochaeta | 2 | 7 | 5 | 3 | 1 | 2 |
| | | 106 | 109 | 121 | 104 | 112 | 106 |

Table 2. VSCI metrics calculated from the macroinvertebrates collected 14 March 2012 at six aquatic sample sites for surface mine permit number 1101760 in Wise County, Virginia

| Family Metrics | Spring 2012 | | | | | |
|-----------------------|-------------|--------|--------|--------|--------|-------|
| | BRFK-1 | BRFK-2 | BRFK-3 | BRFK-4 | BCPT-1 | BPR-1 |
| Taxa Richness | 9 | 8 | 7 | 8 | 10 | 11 |
| EPT Taxa | 4 | 3 | 3 | 4 | 6 | 6 |
| % Ephemeroptera | 0 | 0 | 0 | 9.62 | 12.5 | 16.98 |
| % PT - Hydropsychidae | 14.2 | 2.8 | 6.6 | 9.6 | 58 | 41.5 |
| % Scrapers | 0 | 0 | 0 | 0.96 | 1.79 | 20.75 |
| % Chironomidae | 11.32 | 32.11 | 32.23 | 37.5 | 7.14 | 6.6 |
| % 2 Dominant | 78.3 | 79.82 | 85.12 | 71.15 | 75.89 | 51.89 |
| HBI | 5.28 | 5.7 | 5.73 | 5.38 | 3.38 | 3.35 |
| VSCI | 38.31 | 28.82 | 28.71 | 36.18 | 56.12 | 66.66 |

Table 3. Physiochemical water data collected 14 March 2012 at six aquatic sample sites for surface mine permit number 1101760 in Wise County, Virginia.

| Parameter | BRFK-1 | BRFK-2 | BRFK-3 | BRFK-4 | BCPT-1 | BPR-1 |
|---------------------------|--------|--------|--------|--------|--------|-------|
| Temperature (Celsius) | 12.6 | 13 | 12.6 | 12.8 | 11.9 | 14.1 |
| Specific Conductance (µs) | 1147 | 1182 | 1163 | 1180 | 807 | 965 |
| pH | 7.97 | 8.22 | 8.31 | 8.37 | 8.17 | 8.12 |
| Dissolved Oxygen mg/l) | 11.9 | 11.98 | 11.93 | 12.14 | 11.89 | 11.4 |

APPENDIX C:
PERSONNEL RESUMES



EDUCATION

Masters of Science, Biology, Eastern Kentucky University, Commenced 2003
Bachelors of Science, Wildlife Management, Eastern Kentucky University, 2001
Associates of Science, Southeast Community College, 1997

AREAS OF SPECIALIZATION

- Federally Threatened and Endangered Species Surveys: Aquatic and Terrestrial
- Threatened and Endangered Species Monitoring
- Floral and Fauna Field Investigations
- Aquatic Surveys and Assessments
- USACE Permitting

SUMMARY OF QUALIFICATIONS

Mr. Isaac, a Senior Biologist /Project Manager for Appalachian Technical Services, Inc. has conducted numerous surveys for federally threatened and endangered species of flora and fauna both terrestrial and aquatic in several states. Mr. Isaac is qualified and proficient in; conducting terrestrial and aquatic biological assessments, bat surveys, mussel surveys, botanical surveys, small mammal surveys, fish surveys, crayfish surveys, macroinvertebrate collection and identification, water quality monitoring, USACE permit applications, stream delineation and classification, mitigation site assessments, wetlands delineations, and composing study plans and scientific reports.

Mr. Isaac is permitted by the:

- U.S. Fish and Wildlife Services
- West Virginia Division of Natural Resources
- Virginia Department of Game and Inland Fisheries
- Kentucky Department of Fish and Wildlife Resources
- North Carolina Wildlife Resource Commission

AQUATIC SURVEY EXPERIENCE

- Collection and identification of the freshwater mussel species of Kentucky, southwest Virginia, northeastern Tennessee, and central Ohio
- Qualitative surveys for live and relic freshwater mussels using snorkeling techniques and the use of viewing buckets
- Use of plot sampling to quantitatively survey freshwater mussels
- Field identification of live individuals and lab identification and curation of relict shells collected during surveys
- Assisted in numerous quantitative and qualitative mussel surveys with VDGIF, USFWS, USGS, Virginia Tech, and Steve Ahlstedt in Tennessee, Virginia, and Ohio
- Identification and curation of aquatic insects
- Quantitative and qualitative sampling methods for aquatic macroinvertebrates

- Virginia State Endangered variegate darter (*Etheostoma variatum*) surveys
- Federal Candidate Clinch Dace (*Phoxinus sp. cf. saylori*) surveys
- Stream habitat assessments for the Clinch Dace (*Phoxinus sp. cf. saylori*)
- Assisted in the two year monitoring of Federally Threatened blackside dace (*Phoxinus cumberlandensis*) in Colliers Creek, Letcher County, Kentucky
- Conducted the two year monitoring of Federally Threatened blackside dace (*Phoxinus cumberlandensis*) in Breedens Creek, Harlan County, Kentucky
- Exploratory surveys and population assessments for the federally threatened blackside dace (*Phoxinus cumberlandensis*)
- Virginia State Endangered big sandy crayfish (*Cambarus veteranus*) surveys
- Identification of the crayfish of Kentucky and southwest Virginia
- Identification and Ecology of the fishes of Kentucky and southwest Virginia
- Collection of physiochemical water quality data
- Application of Rosgen stream classification techniques
- Collection of fluvial geomorphologic stream data for mitigation and restoration
- Mitigation site assessments
- Drawing stream profiles and cross sections
- Wetlands delineations

TERRESTRIAL SURVEY EXPERIENCE

- Listed on the USFWS and KDFWR approved bat researchers list
- Identification of eastern forest bats including the Federally Endangered - Indiana bat, Virginia big-eared bat, and the gray bat
- Bat surveys in Kentucky, Tennessee, Virginia, North Carolina, West Virginia, and Pennsylvania
- Surveys for federally threatened/endangered bats using mist nets and harp traps
- Monitoring studies of the Indiana bat
- Summer and wintering habitat evaluations for Indiana bats
- Summer roost emergence counts for Indiana bats
- Bridge evaluations for use by bats
- Abandoned mine evaluations for bat use
- Radio-Telemetry
- Accompanied KDFWR, USFS and USFWS personnel on Priority 1 and Priority 2 Indiana bat and Virginia big-eared bat hibernacula counts in eastern Kentucky
- Co-hosted Mist Netting Workshop for WVDEP Personnel May 2006
- Mist netting and harp trapping at cave entrances of Priority 1 and Priority 2 hibernacula for Indiana bats and gray bats
- Identification of woody and herbaceous plants: aquatic and terrestrial
- Identification of small mammals; moles, shrews, voles, mice, jumping mice
- Established pitfall arrays for small mammal collecting and site selection of snap traps
- Identification and curation of small mammal specimens
- Experience identifying reptiles and amphibians
- Curation of amphibians and entry into museum database
- Identification of migratory birds and waterfowl of the Eastern US

RELATED COLLEGE CURRICULUM

Scientific Literature, Freshwater Invertebrates, Ichthyology, Aquatic Entomology, Aquatic and Wetland Plants, Mammology, Ornithology, Botany, Plant Systematics, Dendrology, Zoology, Wildlife Techniques, Ecology, Migratory and Residential Wildlife Management and Ecology, Field Studies in Wildlife, Wildlife Management, Wildlife Resource Policy and Administration, Big Game Ecology, Principles of Biological Systems, Animal Physiology, Evolution, Geographic Information Systems, Geology, Principles of Soils, and Cartography / Map Design.

CERTIFICATIONS AND TRAINING

2011 North American Benthological Society Eastern EPT Genus Level Taxonomic Certification
2010 North American Benthological Society Family Level Taxonomic Certification
2007 Bat Conservation International, Acoustic Monitoring Workshop
2007 Virginia Tech Coal Mining & the Aquatic Environment Symposium
PADI Open Water Scuba Diver with specialties; Drysuit Diver, Enriched Air Diver
2006 Bat Conservation International, Kentucky Workshop
Applied Fluvial Geomorphology, Level 1 Rosgen Certification
38 - Hour U.S.A.C.E. Wetland Delineation & Management Training Program
USDA Nuisance Animal Trapping Workshop
USDA Coyote and Bobcat Trapping Workshop
Pre-rabies exposure vaccination
Virginia Surface Miner Certificate (with annual MSHA Retraining)
OSHA Construction Safety & Health Training

PROFESSIONAL EXPERIENCE

Senior Biologist – ATS (July 2006 - Present)
Director of Ecological Services – Apogee Environmental Consulting, Inc. (April 2006 – July 2006)
Director of Ecological Services – ATS (Nov 2003 – April 2006)
Terrestrial Ecologist – ATS (April 2002 - Oct 2003)
Staff Ecologist – ATS (August 2001 – March 2002)
Biological Technician – ATS (June 2001 – August 2001)
Guide / Naturalist – Lilley Cornett Woods, (1999 and 2000)